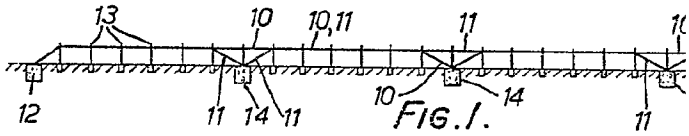

FIG. 1.

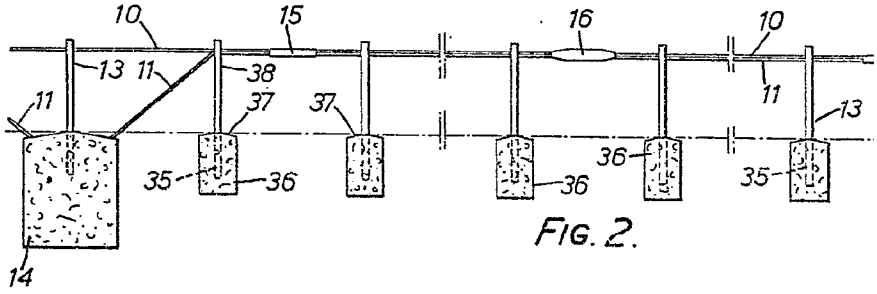

FIG. 2.

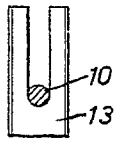

FIG. 3.

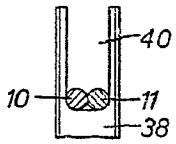

FIG. 4.

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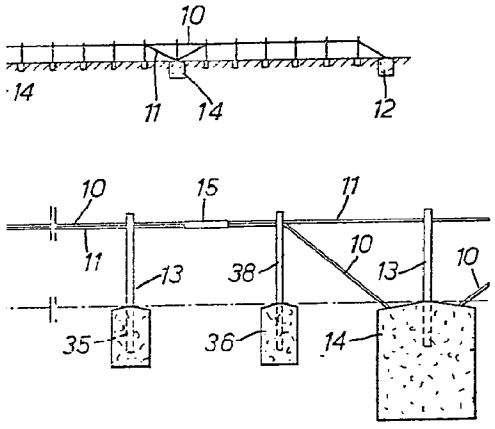

FIG. 5.

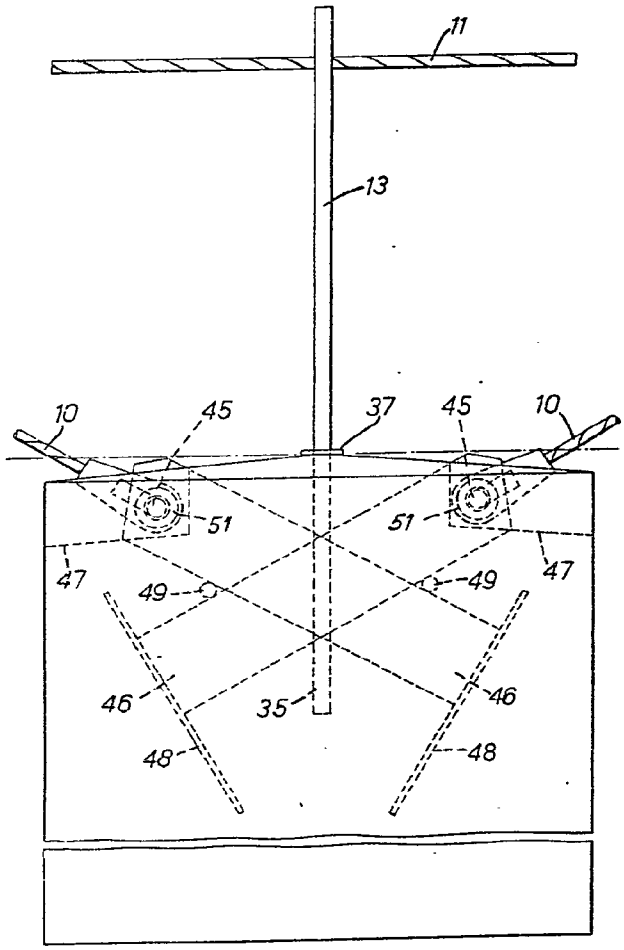

FIG. 6.

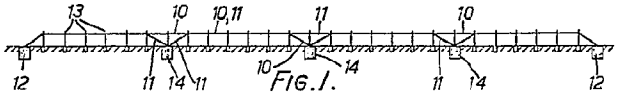

FIG. 1.

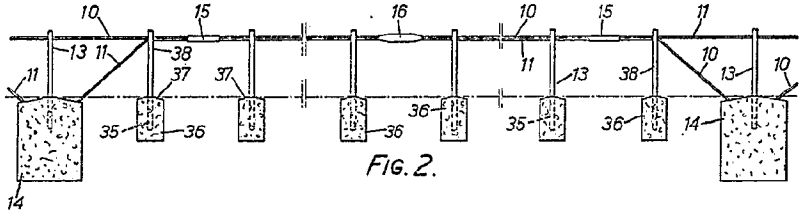

FIG. 2.

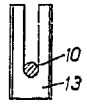

FIG. 3.

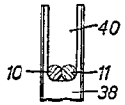

FIG. 4.

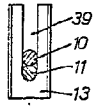

FIG. 5.

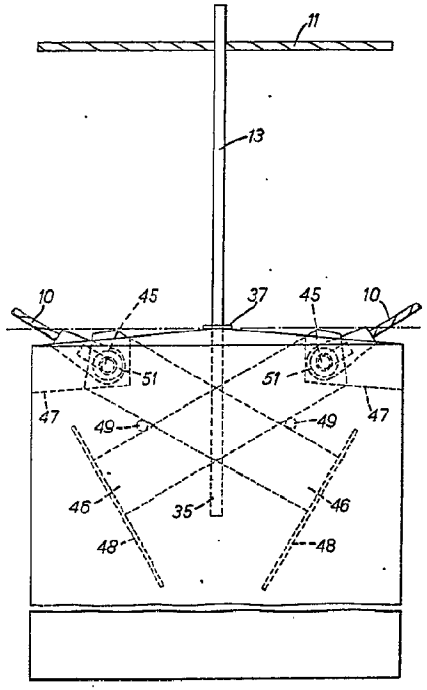

FIG. 6.

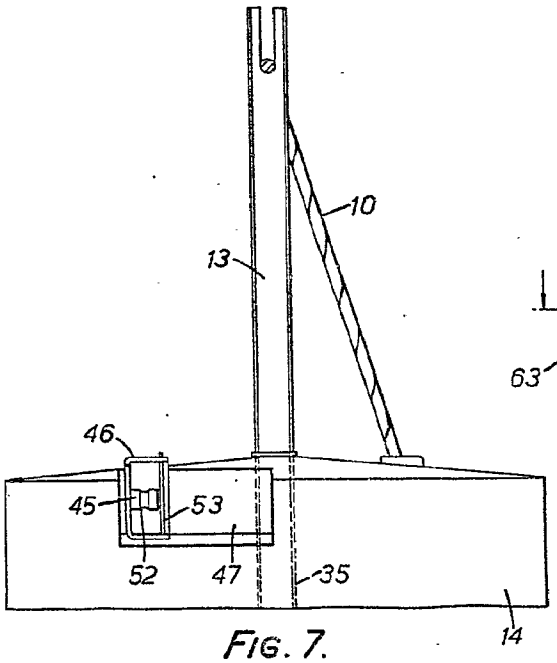

FIG. 7.

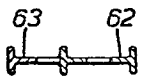

FIG. 14.

FIG. 13

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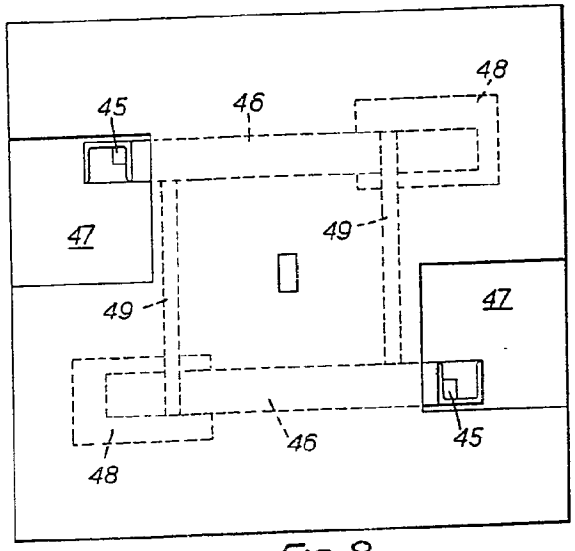


FIG. 8.

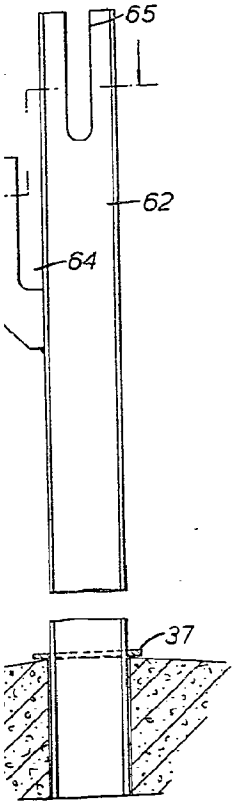


FIG. 13.

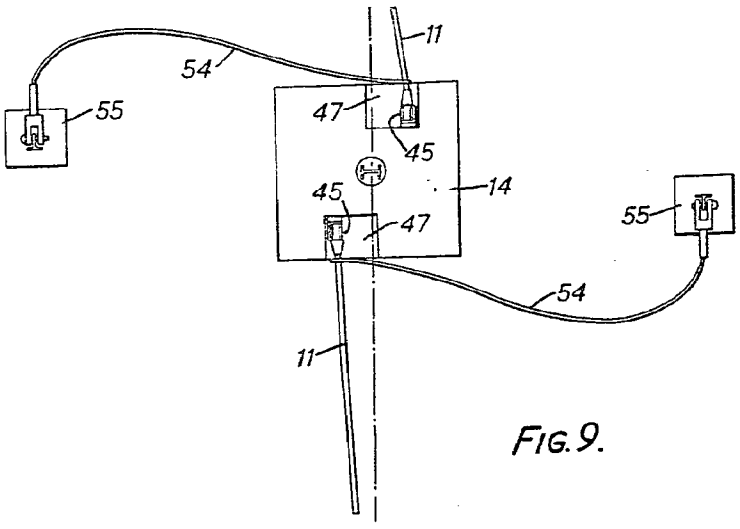
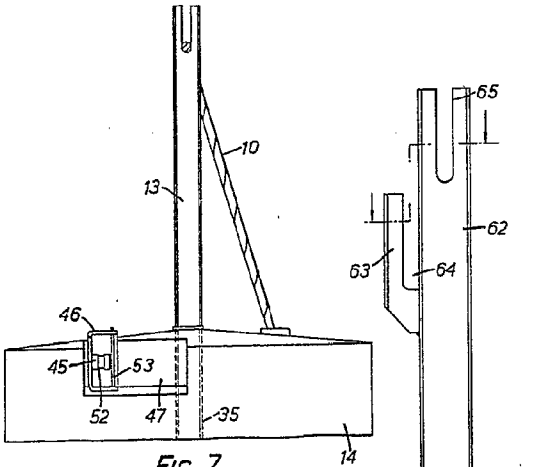


FIG. 9.



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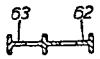


FIG. 14.

FIG. 13.

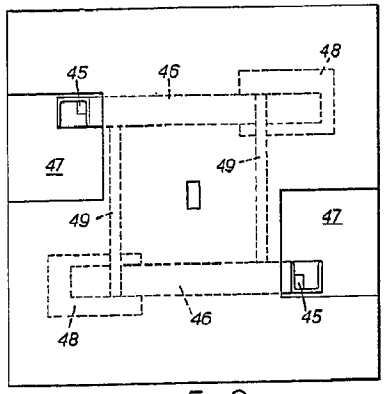


FIG. 8.

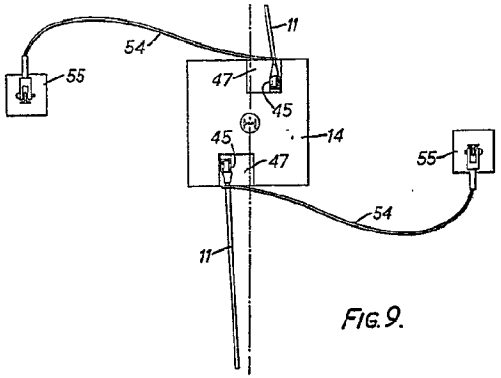
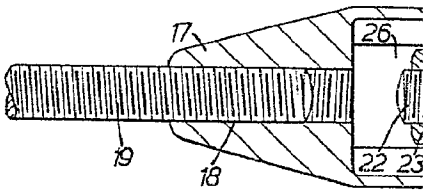


FIG. 9.



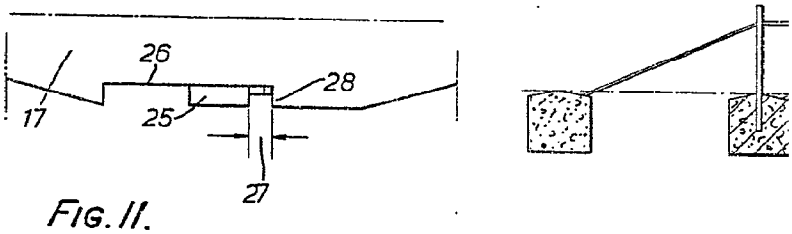
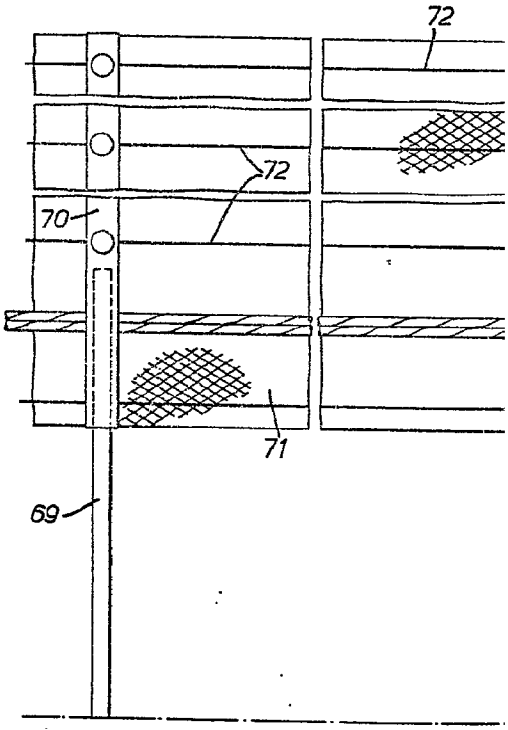


FIG. 11.



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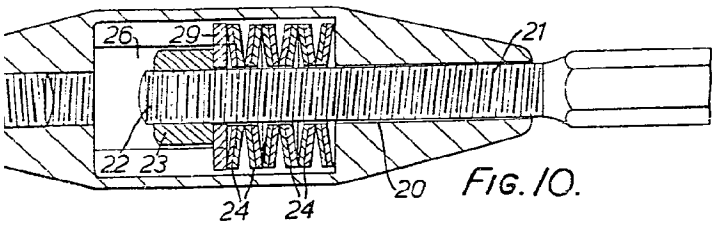

FIG. 10.

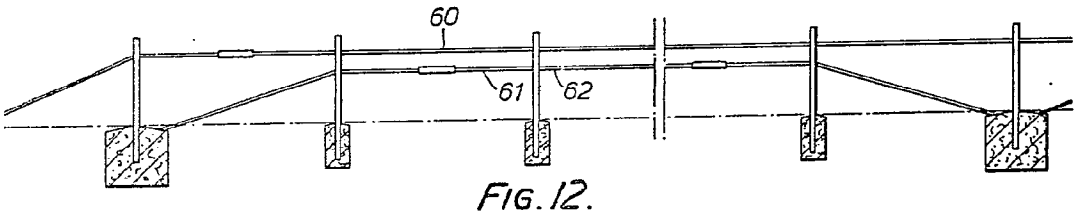

FIG. 12.

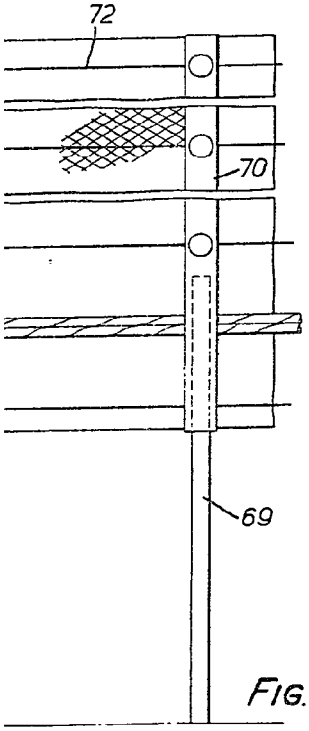

FIG. 15.

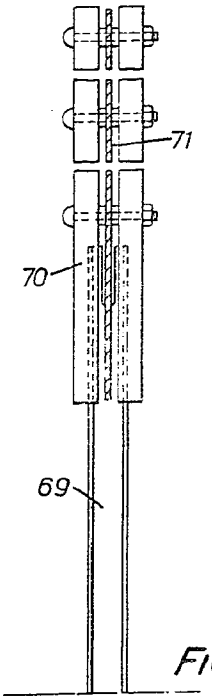

FIG. 16.

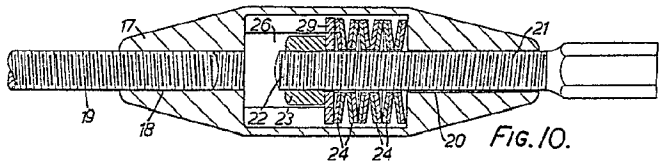

FIG. 10.

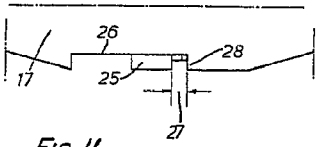

FIG. 11.

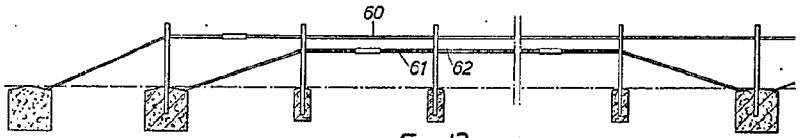

FIG. 12.

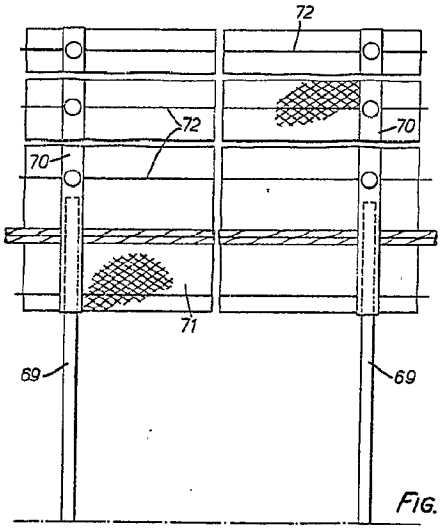

FIG. 15.

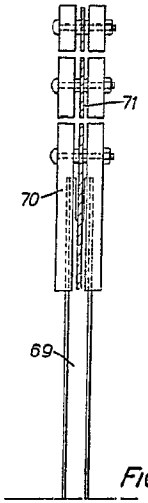

FIG. 16.

PATENT SPECIFICATION 1,103,873

DRAWINGS ATTACHED.

Inventors:—VICTOR JAMES JEHU and LEONARD CHARLES PEARSON.

1,103,873

Date of filing Complete Specification: 22 Sept., 1965.

Application Date: 22 Sept., 1964. No. 38673/64.

Complete Specification Published: 21 Feb., 1968.

Index at Acceptance:—E1 G53A.

Int. Cl.:—E 01 f 15/00.

COMPLETE SPECIFICATION.

Improvements in or relating to Safety Fences.

We, NATIONAL RESEARCH DEVELOPMENT CORPORATION, a British Corporation established by Statute, of Kingsgate House, 66—74 Victoria Street, London, S.W.1, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to safety fences designed to redirect or prevent passage of vehicles over prohibited ground, and is particularly though not exclusively applicable to safety fences used on the sides or central reservations of high speed roads.

It is known to provide safety fences consisting of a number of spaced upright posts to which are clamped a number of horizontal wire ropes. Such known safety fences however suffer from certain disadvantages although in certain conditions they may operate satisfactorily. In particular it has been found that these prior fences may be satisfactory where a vehicle approaches the fence at a relatively large angle of impact exceeding 20° whereas at small angles of impact below approximately 10° the vehicle may tend to spin or roll off the fence with consequent danger to the occupants of the vehicle. It is believed that one of the factors contributing to this hazard is the fact that the ropes are normally clamped to the steel posts by means of U-bolts or other heavy attachment devices which are strong enough to withstand the collision loading.

It is an object of the present invention accordingly to provide an improved safety fence which will overcome or at least partially mitigate some of the disadvantages referred to. The invention consists broadly in a safety fence comprising one or more generally horizontal guard members held in tension between a number of upright posts, which provide support means for holding the guard members in position but permitting the guard members to separate from the posts under impact. Although this separation of the guard members from the posts improves the effectiveness of the fence, if the guard members are clamped to the posts by clips or other devices designed to fracture when a vehicle collides with the fence the guard members may be separated from the posts at points far ahead of the actual point of impact, in which case the vehicle may run over the fence and be overturned. Preferably therefore the support means are arranged to permit or facilitate separation of the respective guard member only when the respective post becomes inclined appreciably from the vertical.

Thus in a preferred form of the invention the guard members comprise cables and the support means consists of a series of vertical slots formed in the posts or in parts attached thereto, and of sufficient width to receive the cables as a slack fit therein.

By this means the cables tend to act as a continuous beam having little or no lateral stiffness so as to redirect a colliding vehicle smoothly onto the proper roadway. By suitable choice of post spacing, cable tension and length the permitted penetration of the fence by a vehicle can be quite substantial so that the lateral deceleration experienced by the vehicle and its occupants is reduced, though the penetration must, of course, be limited to a specified figure to prevent the vehicle from reaching the opposite carriageway of a dual carriage road.

According to a preferred feature of the invention the support means permit free endwise movement of the cables relative to the posts and *vice versa*.

There is an optimum dimension for the depth of the slots, and also their shape. If the slots are too shallow the cables may be released far ahead of the point of impact of the vehicle whereas if the slots are too deep the cables may not be released until the cables have been carried laterally a considerable distance and the posts bent through a substantial angle. This would result in the cables being carried down to the ground with the posts in which case the vehicle might then over-run the cables. Thus preferably the shape and depth of each slot is such that when a cable is displaced laterally, for example by impact of a vehicle, the cable is not displaced from the slot until the respective post has been bent through an appreciable angle from the vertical, but is released from the slot before the post has been bent through an angle approaching 90°.

In practice the depth of the slots is preferably between 3″ and 6″ and more particularly the depth may be approximately $4\frac{1}{2}$″.

In one construction according to the invention one or more cables are supported in slots at an intermediate height on each post, formed by attaching a bracket member to the side of each post. In another construction two cables are positioned one above the other, or side-by-side, in slots at the tops of the posts. In yet another construction brackets may be secured on each side of the posts at their top ends, so that as many as six cables can be run at the same height: this may be valuable where the permitted penetration is extremely small.

In any case each post is preferably of a cross section having a main web and at least one flange, such as an I-section, with the main web of the section extending transversely to the direction of the cables. The post therefore has its weak axis in the direction of the fence and can more easily be run down.

Preferably the fence includes two or more cables, and intermediate anchorages for the cables close to or below ground level.

The intermediate anchorages of different guard members are preferably staggered along the length of the fence, and are designed to allow the respective cable ends to be released laterally.

Thus each anchorage may include a substantially horizontal spigot extending transversely to the line of the fence, and the respective cable end is provided with a loop passing over the spigot.

Conveniently each intermediate anchorage has two spigots for the two interrupted ends of the respective cable, the spigots extending in opposite directions.

According to another preferred feature of the invention the anchorage point for the cable end is displaced laterally from the line of the fence, and is arranged to allow the cable end to be released by movement laterally towards the fence centre line. Furthermore the anchorage may include a slack tension element arranged to limit the movement of the cable end when released from the anchorage.

The safety fence will in any case preferably include a tension indicator in one or each cable.

Each tension indicator preferably includes a resilient member acting between two end members, the end members being formed with projecting surfaces, the displacement between which provides an indication of spring tension. The resilient member may be a compression spring, such as a series of Belleville washers, and in a preferred construction the tension indicator comprises a hollow body with tapered ends, one end having an aperture receiving a tension rod having an enlarged head or nut within the hollow body, and a compression spring between the enlarged head, and the end of the hollow body adjacent the aperture.

The safety fence may also include means for supporting an anti-dazzle screen on the posts.

The invention may be performed in various ways and a number of possible embodiments will now be described by way of example with reference to the accompanying drawings, in which

Figure 1 is a somewhat diagrammatic side elevation of one form of safety fence according to the invention,

Figure 2 is a side elevation on an enlarged scale showing a section of the fence between two intermediate anchorages,

Figure 3 is a fragmentary end view on an enlarged scale of the top end of one of the anchorage posts,

Figure 4 is a similar fragmentary end view of the top end of a support post immediately adjacent an anchorage,

Figure 5 is a similar fragmentary end view of the top end of a standard support post,

Figure 6 is a side elevation on an enlarged scale of one form of intermediate anchorage according to the invention,

Figure 7 is an end view of the anchorage of Figure 6,

Figure 8 is a plan view of the anchorage of Figure 6,

Figure 9 is a plan view of the anchorage of Figure 6 on a reduced scale, showing the check wires,

Figure 10 is a sectional side elevation on an enlarged scale through a tension indicator,

Figure 11 is a fragmentary plan view of part of the tension indicator of Figure 10,

Figure 12 is a side elevation of a modified form of fence according to the invention,

Figure 13 is an end elevation on an enlarged scale of one of the support posts of Figure 12,

Figure 14 is a plan view of the post of Figure 13, and

Figures 15 and 16 are respectively a side elevation and elevation of an anti-glare screen mounted on top of a safety fence.

In the first example as illustrated in Figures 1 to 11 the safety fence consists of two $\frac{3}{4}$" diameter wire cables 10, 11, each with a breaking load of at least 17 tons, the ends of the cables being secured to concrete end anchorages 12 below ground level at the two ends of the fence and the cables being supported on posts 13 between the anchorages. The distance between the end anchorages 12 of one component rope may depend upon the siting of the fence but in any case should not be less than 150 feet and should not exceed 2,056 feet. In fences of any appreciable length intermediate anchorages 14 are provided, only one rope being carried down to any such intermediate anchorage, which are thus staggered along the length of the fence as between the two ropes. The distance between such intermediate anchorages 14 is preferably at least 250 feet. Turnbuckle adjusting elements 15, as seen in Figure 2, with a smooth external surface may be provided at intervals along the cables to enable the tension of the cables to be adjusted, and to permit a number of separate lengths of cable to be connected together to form a long run. Each such turnbuckle adjuster may comprise an internally screwthreaded barrel having threads of opposite hand at opposite ends, engaging correspondingly threaded cable end terminals. Such turnbuckle adjusters are well known in themselves and require no further description. In practice the tension in each cable should be at least 1,000 lbs. and may be increased to values up to 5,000 lbs. where the permissible penetration distance of a vehicle across the fence is limited. A suitable initial static tension is about 3,000 lbs. at 15°C., which ensures that even on a hot day the tension will not be less than 1,000 lbs., the order of tension necessary to eliminate visible sag of the cables.

The cables are preferably galvanised steel wire rope, of coreless three-strand construction, each strand comprising six wires spun around one king wire. The rope has a tensile strength of between 82 and 95 tons per square inch, calculated on the galvanised wire diameter. The lay length should not exceed $7\frac{1}{2}$ inches, the weight should be approximately 815 lbs. per 1,000 feet, and the modulus of elasticity should not be less than 10,000 tons per square inch.

Each cable run also preferably includes a tension indicator 16 which is illustrated in detail in Figures 10 and 11 and comprises a hollow double-tapered body 17 resembling a turnbuckle having at one end a righthand screwthreaded bore 18 to engage one of the screwthreaded cable ends 19, and at the other end an aperture 20 to receive a rod 21 which is connected to the other cable end, and has a left-hand screwthreaded extremity 22 to receive a nut 23 positioned in the internal cavity of the body. Between the nut 23 and the apertured end of the body are arranged a series of Belleville washers 24 acting as a compression spring when tension is exerted between the two cable ends. The nut 23 is formed with projecting parts 25 extending through side slots 26 in the body, and the tension in the cable is indicated by the gap 27 between one of these projections and a shoulder 28 on the body. The spring design is preferably such that the required tension is provided when the gap is nearly closed. In one particular example, using fourteen Belleville washers and a flat calibrating disc 29 the following load/deflection figures were obtained:

Load (lbs.)	Gap (ins.)
0	.512
1000	.395
2000	.262
2500	.187
3000	.097
3200	.058

Conveniently a GO-NoGO gauge is provided to measure the size of the gap and to ensure that the load is within a predetermined range.

The adjusting elements 15 and tension indicators 16 are preferably staggered, between the two cables, along the fence with each adjusting element positioned between two intermediate posts, rather than between an anchorage and the adjacent 'end' post, so as to reduce the movement of the cable relative to the 'end posts as it is tightened, and thus avoid bending the posts.

Between the anchorages the cables are supported by the series of upright posts 13 consisting of I-section galvanised mild steel girders with $2\frac{1}{2}$" webs and 1" flanges and a plate thickness of $\frac{1}{4}$". The posts are set in close-fitting rectangular sockets 35 formed in concrete footings 36 with approximately 18" of each post below ground level. The gap between the flanges of each post at ground level is closed by wedges, or covered

with a suitably shaped washer 37 formed of a synthetic plastics material, and a waterproofing substance such as pitch may be applied to prevent water entering the concrete socket. The main web of each post extends in a direction perpendicular to the run of the cables 10, 11 and to the direction of the roadway, so that the main strength of the posts resists lateral impact, the posts being comparatively weak in the direction of the cables so that they will be knocked down by a vehicle colliding with the posts themselves. In the upper end of each post 13, excluding those posts 38 immediately adjacent to the intermediate and end anchorages 12 and 14, a vertical slot 39 is formed in the web, $4\frac{1}{2}''$ deep and $\frac{3}{4}''$ wide as shown in Figure 5, and the two cables 10, 11 rest in these slots one above the other so that the lower cable is at a height above ground level of approximately 27".

The posts 38 immediately adjacent one of the anchorages have wider slots 40 formed in their upper ends, as seen in Figure 4, and the two cables rest side-by-side in these slots. At each intermediate anchorage the post 13 has the narrower form of slot in its upper end, there being only one cable at this point, as seen in Figure 3.

It will be seen that if any posts are knocked down in any direction the cables will continue to be supported by adjacent posts, and will readily become detached from the posts which have been knocked down, so that the cables are not carried down to the ground.

Each intermediate anchorage as best seen in Figures 6, 7, 8, and 9, comprises a concrete block 14 having a central socket 35 to receive a post 13 as described above, and also having means for attaching two cable ends of an interrupted cable 11 at or slightly below ground level. Each such cable attachment comprises a short spigot 45 welded to the upper end of the web of a length of channel-section girder 46 embedded in the concrete, the spigot extending horizontally in a direction perpendicular to the line of the fence. The lower ends of the two girders 46 have plates 48 welded thereto, and the two girders are interconnected rigidly by crossbars 49, the whole being solidly set in the concrete block 14. The spigots 45 are offset on opposite sides of the centre line of the fence and each extends inwards towards the centre line, there being a recess 47 formed in the concrete between the spigot and the centre line. Each cable end of the interrupted cable is firmly connected to a closed loop or eye 51 to fit over the respective one of the spigots, and the spigot is formed with a shallow annular peripheral groove 52 to assist in locating the eye correctly. The flanges of the channel-section girder are formed with drillings to receive a temporary locating pin 53 lying across the end of the spigot to prevent the eye being accidentally released during assembly or cable tensioning. A vehicle striking the cable adjacent the intermediate anchorage will cause the eye to become detached from the spigot, and to prevent the cable end "snaking" dangerously a short wire rope tie 54 is provided between the cable end and the base of an adjacent post, or specially located anchor point 55, as shown in Figure 9.

The two spigots 45 provided at each intermediate anchorage are spaced apart in the direction of the fence, and symmetrically offset from the centre line as seen in Figure 9, so that the anchorage can be struck from either side. The short gap between the spigots provides an escape path for any vehicle which may have straddled the cable and so have become trapped. At each intermediate anchorage one only of the two cables is interrupted, the other being continued horizontally through to the next anchorage, so that a continuous barrier is presented.

The end anchorages 12 are of substantially the same construction as the intermediate anchorages, but have only one spigot.

In the second embodiment of the invention illustrated in Figures 12 to 14, the safety fence has two cables 60, 61 supported at different heights. The upper cable 60 is supported at a height of 30" above ground in vertical slots 65 at the tops of the posts 62. The lower cable 61 is supported at a height of 25" above ground in slots 64 formed by brackets 63 welded to the side flanges of the posts. Each bracket is of T-section as seen in Figure 14 with the edge of the web thereof welded to the main post flange, and the upper part of the web of the T-section cut away to form a slot $4\frac{1}{2}''$ in depth. Thus it will be seen that there is an uninterrupted free entry into and exit for the upper and lower cables into and out of the slots, and as a result both the upper and lower cables will be readily released if the posts are bent sideways, or knocked down in the direction of the fence, irrespective of which side of the fence receives the impact.

By using slots on both sides of the posts in addition to those in the post tops a fence with cables at three heights can be constructed. Alternatively three slots at the same height can be provided at the tops of the posts, to accommodate up to six cables, in situations where the permissible vehicle penetration distances are extremely limited. Many other combinations and arrangements are possible, as will be apparent.

The method of providing slots for the cables at the sides of the posts also facilitates construction of a fence to serve both

as a vehicle guard rail and as an anti-glare screen. Thus, as shown in Figures 15 and 16, with the cables resting in slots at the sides of I-section steel posts 69, the webs of the posts are left clear to be used as the means of mounting taller frangible posts 70 conveniently in the form of aluminium tubes, which in turn support some form of anti-glare infilling such as expanded metal sheets 71, through which are threaded strainer wires 72 attached to the posts 70. The infilling extends from 1'8" to 5'8" above the road level. The anti-glare screen should disintegrate upon impact and thus have no adverse effect upon the action of the cables and their steel support posts in redirecting a vehicle smoothly along the fence.

Fences according to the invention will operate effectively over a wide range of angles of impact. The vertical walls of the slots in the posts provide considerable lateral restraint for the cables so that when a vehicle collides with the fence all the adjacent posts will tend to bend across the line of the fence, thus decelerating the vehicle. When any post reaches the predetermined angle of inclination the cables will become released from the slots and these posts will then be knocked down in the direction of their weak axis by the vehicle itself, but the height of the cables will not be substantially altered. After the impact the fence can be repaired simply by extracting damaged posts, inserting new ones, replacing the cables in the slots, and if necessary readjusting the cable tension.

WHAT WE CLAIM IS:—

1. A safety fence comprising one or more generally horizontal guard members held in tension between a number of upright posts, which provide support means for holding the guard members in position but permitting the guard members to separate from the posts under impact.

2. A safety fence as claimed in claim 1, in which the support means are arranged to permit or facilitate separation of the respective guard member only when the respective post becomes inclined appreciably from the vertical.

3. A safety fence as claimed in any of the preceding claims, in which the support means permit at least limited free endwise movement of the guard members relative to the posts and *vice versa*.

4. A safety fence as claimed in claim 1, or claim 2, or claim 3, in which the guard members are in the form of cables located in generally vertical slots formed in the posts, or in parts attached thereto.

5. A safety fence as claimed in claim 4, in which the shape and depth of each slot is such that when a cable is displaced laterally, for example by impact of a vehicle the cable is not displaced from the slot until the respective post has been bent through an appreciable angle from the vertical, but is released from the slot before the post has been bent through an angle approaching 90°.

6. A safety fence as claimed in claim 4, or claim 5, in which the depth of the slots is between 3" and 6" and preferably approximately 4½".

7. A safety fence as claimed in any of the preceding claims, in which one guard member is supported in slots at an intermediate height on each post, formed by attaching a bracket member to the side of each post.

8. A safety fence as claimed in any of the preceding claims, in which each post has a cross section comprising a main web and at least one flange, with the main web of the section extending transversely to the direction of the cables.

9. A safety fence as claimed in any of the preceding claims, including two or more cables, and intermediate anchorages for the cables close to or below ground level.

10. A safety fence as claimed in claim 9, in which the intermediate anchorages of different cables are staggered along the length of the fence.

11. A safety fence as claimed in claim 9, or claim 10, in which the intermediate anchorages are designed to allow the respective cable ends to be released laterally.

12. A safety fence as claimed in claim 11, in which each anchorage includes a substantially horizontal spigot extending transversely to the line of the fence, and the respective cable end is provided with a loop passing over the spigot.

13. A safety fence as claimed in claim 12, in which each intermediate anchorage has two spigots for the two interrupted ends of the respective cable, the spigots extending in opposite directions.

14. A safety fence as claimed in any of claims 11, 12, or 13, in which the anchorage point for the cable end is displaced laterally from the line of the fence, and is arranged to allow the cable end to be released by movement laterally towards the fence centre line.

15. A safety fence as claimed in any of the preceding claims, including an auxiliary slack tension element arranged to limit the movement of the end of a guard member when released from an anchorage.

16. A safety fence as claimed in any of the preceding claims, including a tension indicator in one or each guard member.

17. A safety fence as claimed in claim 16, in which the tension indicator includes a resilient member acting between two end members, the end members being formed with projecting surfaces, the displacement

between which provides an indication of spring tension.

18. A safety fence as claimed in claim 17, in which the resilient member is a compression spring, such as a series of Belleville washers.

19. A safety fence as claimed in claim 18, in which the tension indicator comprises a hollow body with tapered ends, one end having an aperture receiving a tension rod and having an enlarged head or nut within the hollow body, and a compression spring lying between the enlarged head and the end of the hollow body adjacent the aperture.

20. A safety fence as claimed in any of the preceding claims, including means for supporting an anti-dazzle screen on the posts.

21. A safety fence substantially as described with reference to Figures 1 to 3, or Figures 12 to 14, with or without the constructional elements of Figures 6 to 11, or Figures 15 and 16, of the accompanying drawings.

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